Office of National Marine Sanctuaries/National Centers for Coastal Ocean Science Long-term Agreement (ONMS/NCCOS LTA)

2004 Annual Liaison Report on Existing and Potential ONMS/NCCOS Collaborative Studies at the Gray's Reef National Marine Sanctuary (GRNMS)

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1. Introduction

In April 2000, the National Centers for Coastal Ocean Science (NCCOS) and the Office of National Marine Sanctuaries (ONMS) began a partnership with the purpose of augmenting the management of the National Marine Sanctuaries (NMS) through increased scientific understanding of the sanctuary sites. The first few years of the partnership saw NCCOS scientists working with a handful of sanctuaries. As the partnership matured, collaborative efforts between NCCOS and ONMS increased, and in FY2004 and FY2005, research projects are tentatively funded in 9 of the 14 sites. In addition to research, NCCOS has appointed liaisons to each of the sites. Liaison duties include: being knowledgeable of science activities and capabilities of NCCOS, being knowledgeable of the site's management needs, being knowledgeable of ongoing research and science needs in the site, identifying and assessing research gaps and areas of potential collaboration between NCCOS and ONMS, and working with the site to refine and address their science needs to meet their management objectives.

2. Sanctuary Overview

The National Marine Sanctuary Program was created by Congress through Title III of the Marine Protection, Research and Sanctuaries Act of 1972. The Act allowed marine areas identified for their biodiversity, ecological integrity, and cultural legacy to receive protection similar to national parks.

Gray's Reef National Marine Sanctuary (GRNMS) was designated in 1981 and was named in recognition of Milton B. Gray, who studied the area in the 1960's as a biological collector and curator at the University of Georgia Marine Institute on Sapelo Island, Georgia. The sanctuary is managed through an office on Skidaway Island, Georgia.

GRNMS is located 32 kilometers east of Sapelo Island, Georgia and encompasses 58 square kilometers (Figure 1). Water depth is approximately 20 m and the bottom consists of extensive but discontinuous rock outcropping of moderate height (2-3 m) interspersed with unconsolidated sediments of sand and shell hash. In some areas, sand forms a thin (1-10 cm) veneer covering

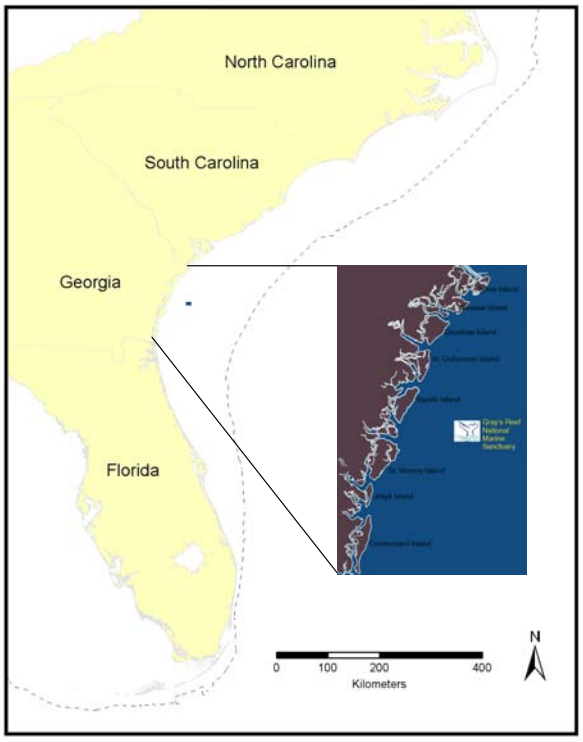

Figure 1. Map of southeast United States continental shelf and inset showing location of Gray's Reef National Marine Sanctuary. Inset from http://www.graysreef.nos.noaa.gov/location.html (link last checked on 10 November 2003).

underlying rock. Various sessile organisms attach to the rock and grow up through the sand, creating what is called locally 'live-bottom'. The rocky outcrops, 'live-bottom' areas, and bare unconsolidated sediments create a complex habitat for many algae, invertebrates, and vertebrates.

Dominant invertebrates include sponges, barnacles, sea fans, hard coral, sea stars, crabs, lobsters, snails, and shrimp. Numerous species of benthic and pelagic fish also occur in the sanctuary, including black sea bass, gag, and king mackerel. Loggerhead sea turtles, a threatened species, use Gray's Reef year-round, and the region around GRNMS and Sapelo Sound is the only known winter calving ground for the highly endangered northern right whale. In addition to living organisms, fossil bivalves and gastropods, and mastodon bones have been found in the sanctuary. The mastodon bones indicate that the area was once a shallow coastal environment and there may exist extant prehistoric cultural resources within the sanctuary.

Currently, regulations prohibit: alteration of the seabed; discharge of any material; use of wire fish traps; use of bottom trawls; damage to or removal of bottom formations including invertebrates and plants; taking any tropical fish; using poisons, electric charges, or explosives to take any marine animal not otherwise prohibited; and tampering with, damaging, or removing any historic or cultural resources [1]. GRNMS enforces these regulations through an interagency agreement with the U.S. Coast Guard and the National Marine Fisheries Enforcement Division. Allowed activities included recreational and commercial hook-and-line fishing and recreational diving. Little commercial ship traffic transits through the area, but is allowed.

3. Management Goals and Concerns

GRNMS is managed under a 1983 management plan. This plan is currently under revision and a draft management plan was distributed for review in November 2003[2]. Public hearings were held in November and December 2003 and comments were accepted through 31 December 2003. The Draft Plan is still not approved, but for the purposes of this report, the Draft Management Plan will be used as a basis for GRNMS management goals and concerns.

GRNMS and the Sanctuary Advisory Council adopted the following goals in 2000.

- Protect, maintain, restore, and enhance natural habitats, populations, and ecological processes in the sanctuary.
- Support, promote, and coordinate scientific research and long-term monitoring to enhance the understanding of the sanctuary environment and to improve management decision-making.

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[1] A complete list of prohibited activities is available at http://www.graysreef.nos.noaa.gov/regs.html (link last checked on 11 January, 2005)

[2] available at http://www.graysreef.nos.noaa.gov/newdraftplan/finaltoprintdmpdeis.pdf (link last checked on 11 January, 2005)

- Enhance public awareness, understanding, wise and sustainable use, and appreciation of the marine environment and the sanctuary's natural, historical, cultural, and archeological resources.
- Facilitate, to the extent compatible with the primary objective of resource protection, all public and private use of the sanctuary not prohibited pursuant to other authorities.
- Dedicate appropriate infrastructure and resources for all programs, and create models of, and incentive for, ways to conserve and manage sanctuary resources including application of innovative management techniques.
- Coordinate with federal, state and local governments, international organizations, and other public and private interests to develop and implement plans to protect the marine environment and the sanctuary, and to encourage the conservation of these resources.

The draft management plan includes a number of strategies to meet the management goals of the sanctuary. These strategies fall into six categories: Marine Resource Protection (MRP), Research and Monitoring (RM), Education and Outreach (EO), Exploration (EX), Administrative (AD), and Performance Evaluation (EV). The various strategies are summarized below and the stated priorities presented in Table 1.

Table 1. Priority of strategies identified in Gray's Reef National Marine Sanctuary Draft Management Plan

1st Priority	2nd Priority	3rd Priority
MRP-1 through MRP-6	RM-2 & RM-3	RM-1
RM-4	EO-2 through EO-4	EO-5
EO-1	EX-1	
AD-1	AD-2	
EV-1		

MRP – 1. Prevent damage to benthic habitats from anchoring.
MRP – 2. Prevent diver impacts on benthic habitats.
MRP – 3. Remove marine debris from the sanctuary and prevent new debris from accumulating.
MRP – 4. Increase protection for fish and invertebrate species.
MRP – 5. Enhance enforcement efforts.
MRP – 6. Enhance coordination and cooperation with South Atlantic Fishery Management Council (SAFMC), NOAA Fisheries, and Georgia Department of Natural Resources on marine reserves and other regional programs.
RM – 1. Investigate ecosystem processes.
RM – 2. Investigate designation of marine research area.
RM – 3. Assess and characterize sanctuary resources.
RM – 4. Maintain and enhance monitoring programs.
EO – 1. Conduct public awareness programs.
EO – 2. Create and provide scholastic programs in ocean science education.
EO – 3. Maintain existing and develop new sanctuary exhibits.
EO – 5. Increase outreach to minority communities.
EO – 6. Develop volunteer programs to support sanctuary programs.

EX – 1. Develop and implement the latitude 30° 30' N Program.
AD – 1. Improve overall site staffing and support capabilities.
AD – 2. Maintain and enhance the infrastructure of the site.
EV – 1. Develop and implement a performance evaluation program for the GRNMS

Two new regulations are proposed in the Draft Management Plan: prohibition of anchoring in GRNMS except in emergency situations, and fishing only with rod and reel and hand-line gear (e.g., prohibiting longline, pots, nets, spearguns, etc.). These additional regulations are proposed to meet the goals of the sanctuary, and to satisfy the identified marine resource protection strategies. Limitation of anchoring would minimize damage to bottom habitats (MRP-1). Restriction of fishing gear would further limit but not prohibit the extraction of fish from the sanctuary (MRP-2 and MRP-4).

4. Current Sanctuary Research Projects and Summary of Ongoing and Planned NCCOS/ONMS Partnership Activities

A number of research activities have been conducted and are ongoing in coordination with the sanctuary, and many are a result of the ONMS/NCCOS partnership. Scientists from the Center for Coastal Fisheries and Habitat Research (CCFHR) and the Center for Coastal Monitoring and Assessment (CCMA) have been working with GRNMS as part of the partnership. These projects and other major research projects are identified below.

Trap Reef Fish Assessments – South Carolina Marine Resources Research Institute has conducted fishery-independent fish traps surveys of reef fish throughout the southeast United States continental shelf for close to 30 years. In 1993, limited trapping began in GRNMS to evaluate reef fish trends in the sanctuary relative to the surrounding shelf. Data from this work have been combined with other sources for a compilation of fish species that occur in the vicinity of the sanctuary as part of the Support of Monitoring Activities and Site Characterization project described below.

Visual Reef Fish Assessments – In 1995, GRNMS initiated a visual reef fish monitoring effort to supplement trap surveys. Divers use a point-count method to enumerate the number of fish at ~22 fixed sites in an area of rock outcropping within the sanctuary. CCFHR has participated in the surveys and in preliminary data analysis. Data from this work have been combined with other sources for a compilation of fish species that occur in the vicinity of the sanctuary as part of the Support of Monitoring Activities and Site Characterization project described below.

Development of Alternative Fish Assessment Techniques – The trap and visual reef fish assessment programs are limited spatially and taxonomically. GRNMS is interested in using new techniques to complement ongoing efforts. A cruise was conducted aboard the NOAA Ship Nancy Foster during May 2004. Various techniques were used to simultaneously assess fish present in the sanctuary. A cruise report was posted online (http://oceanica.cofc.edu/Gray's%20Reef%202004/home.htm)

Lionfish Research – CCFHR researchers have described the invasion of lionfish (*Pterois volitans/miles* complex) along the southeast United States continental shelf. A collaborative research effort between North Carolina State University and CCFHR documented the thermal limits of lionfish in the lab and used a climatology of winter bottom temperatures to predict the potential distribution of lionfish on the southeast United States shelf[3]. GRNMS is currently outside of the predicted distribution, because of cool winter bottom temperatures (minimum <10^{o}C), but long-term warming or interannual variability in winter bottom temperatures could allow lionfish to invade into GRNMS.

Physical Oceanographic Properties – Several physical oceanographic studies have been completed in the region of GRNMS. Currently the area is under the domain of the Southeast Atlantic Coastal Ocean Observing System [4]. In addition, a National Data Buoy Center data buoy is located in the sanctuary [5] providing real-time oceanographic data, and an acoustic Doppler current profiler was added to the buoy in March 2003. The GRNMS and the Refugia Concept project described below is collaborating with SEACOOS to integrate physical oceanographic information and biological models to aid sanctuary management.

Benthic Habitats of GRNMS – CCMA and CCFHR scientists recently completed a habitat map for GRNMS. Side-scan sonar data was collected by the NOAA Ship *Whiting* in 2001. NCCOS scientists then used visual-based ground truth data to assign the sonar data to four bottom types: sand plain, rippled sand, sparsely-colonized hard-bottom, and densely-colonized hard-bottom[6]. The resulting habitat map has been used for both management purposes and to aid research. A peer-review publication is in preparation.

Sea Turtle Research – GRNMS tracked the movements of loggerhead turtles at the sanctuary using telemetry tags. These data show that GRNMS is an important area for loggerhead throughout the year. Analysis of the information is ongoing and continuation of these studies is needed.

Paleo-Environmental Conditions – Scientific divers found fossils of extinct land-dwelling animals in GRNMS. Research on these fossils is contributing understanding conditions in coastal Georgia ~10,000 years ago.

Support of Monitoring Activities and Site Characterization – CCFHR researchers have been working with GRNMS since 2000. This project seeks to determine the importance of non-reef habitats to juvenile stages of reef fishes and evaluate the ecological linkages between non-reef and reef habitats. Further, the species of fish that spawn in the vicinity of GRNMS were determined and larval transport to and dispersal from the sanctuary was

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[3] Kimball ME, Miller JM, Whitfield PE, Hare JA (2004) Using temperature tolerance to predict the distribution of the invasive lionfish (Pterois volitans/miles complex) on the east coast of the United States. Marine Ecology Progress Series 283: 269-278.

[4] http://www.seacoos.org/seacoos (link last checked 10 November, 2003)

[5] http://www.ndbc.noaa.gov/station_page.phtml?$station=41008 (link last checked 10 November, 2003)

[6] http://www.graysreef.nos.noaa.gov/newdraftplan/kendallreport.pdf

examined. This study was conducted in cooperation with Halo-effects within GRNMS and Evaluation of Benthic Infauna and Sediment Contamination. One peer-reviewed journal article has been published[7], one has been accepted for publication[8], one has been submitted for publication[9], and several others are in preparation for publication. In addition, and review of trophodynamic information for fish occurring in the vicinity of the sanctuary was completed and an annotated bibliography of references was published in the Marine Sanctuary Conservation Series[10]

GRNMS and the Refugia Concept – This collaborative project in funded currently and seeks to examine the refugia concept from the perspective of GRNMS management-needs, at two scales. At larger-scales, this study will define the source regions providing recruitment to GRNMS and the supply regions receiving recruitment from GRNMS using a 3-D circulation model. At smaller scales, this study will examine the trophic relationships between reef fish inhabiting GRNMS and primary and secondary production in the surrounding ecosystem. Stable isotope analyses have been completed for various species collected in the vicinity of GRNMS. Additionally, diet studies have been completed on approximately 10 species of fish that occur in the sanctuary. These data will be combined to assess the refugia concept on small-scales. From the perspective of large-scale, researchers involved with SEACOOS have been developing a physical oceanographic model to track the fate of larvae spawned at GRNMS and the source of larvae settling to GRNMS. A model validation contract has been completed and a peer-review publication in preparation. The next step involved coupling behavioral models with the physical model to look at specific questions pertinent to GRNMS management questions. This project is scheduled to be funded under the FY04/05 ONMS/NCCOS LTA.

Evaluation of Benthic Infauna and Sediment Contamination – Previous work at GRNMS developed a list of invertebrates associated with the rock outcrops. CCMA researchers complemented and extended this work, by examining benthic macroinfauna in unconsolidated sediments in and around the sanctuary. This work has lead to the development of a webpage documenting the various invertebrate species found at GRNMS[11]. In combination with this work, concentrations of contaminants in sediments and animals were quantified. GRNMS was found to contain background levels of most

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[7] Marancik KE, Clough L, Hare JA. (2005). Cross-shelf and seasonal variation in larval fish assemblages in the Georgia Bight region of the southeast United States continental shelf. Fishery Bulletin 103: 108-129 (available at http://fishbull.noaa.gov/1031/mara.pdf., link last checked 12 January, 2005).

[8] Ferguson RL, Krouse C, Patterson M, Hare JA (in press) Automate geo-positioning of daytime AVHRR images. Photogrammetric Engineering and Remote Sensing.

[9] Walsh HJ, Marancik KE, Hare JA. (in review). Juvenile fish assemblages of unconsolidated sediments on the southeast United States continental shelf off the coast of Georgia, USA. Fishery Bulletin.

[10] Marancik, KE, Hare, JA 2005. An annotated bibliography of diet studies on fish of the southeast United States and Gray's Reef National Marine Sanctuary. Marine Sanctuaries Conservation Series MDS-05-01. U.S. Department of Commerce National Oceanic and Atmospheric Administration, Marine Sanctuaries Division, Silver Spring, Maryland. 56 p. (available at http://www.sanctuaries.nos.noaa.gov/special/con_series/bibli_study.html, link last checked on 12 January, 2005)

[11] http://www.seamonsters.noaa.gov/basics.aspx

contaminants[12] little to no contamination of common land-based pollutants. This study was conducted in cooperation with Support of Monitoring Activities and Site Characterization. A subsequent project has been started that will contribute to management at GRNMS, but that is not funded by the sanctuary program: Georgia Coastal Analysis Partnership[13].

Halo-effects within GRNMS – In FY2003, CCMA researchers evaluated the existence of trophic halos in unconsolidated sediments surrounding rocky outcrops. This work will further evaluate the relationship between reef communities and unconsolidated sediment communities. This study was conducted in cooperation with Support of Monitoring Activities and Site Characterization.

Biogeographic Assessment – In FY2004 and FY2005, CCMA will conduct a biogeographic assessment of GRNMS. The assessment will be based in part on the habitat map developed in FY2002 and FY2003. The assessment will identify and collect relevant biological datasets for the sanctuary and combine these datasets in a GIS framework. CCMA staff will then assist sanctuary staff in integrating the products into sanctuary management. A similar assessment was completed for northern California sanctuaries[14].

5. Research Gaps and Future Needs

ONMS conducted comprehensive assessment of the science activities in the program (Gittings *et al*., 2002)[15]. The information in the assessment was largely identified in a 2001 workshop, which evaluated how well the sanctuary management issues were being addressed by science activity and provided direction for future science resources. The assessment was both across the program and site specific and serves here as a starting point for identifying research gaps and future needs for GRNMS.

Priority information needs identified by Gittings *et al*. (2002) for GNMS include "various types of oceanographic data; specific types of GIS compatible data; effects of fishing/harvest on predator prey dynamics and levels; mechanisms of contaminants causing mortality; and population trends for key species and communities, including rates of growth, mortality, and fecundity."

To further identify research needs, it is necessary to evaluate the needs identified by Gittings *et al.* (2002) with the Research and Monitoring Strategies identified in GRNMS's Draft Management Plan (listed). In general, the research needs identified

[12] http://www.graysreef.nos.noaa.gov/newdraftplan/annualreporthyland02.pdf
[13] http://www.chbr.noaa.gov/cep/project49.aspx
[14] http://biogeo.nos.noaa.gov/products/canms_cd/
[15] Gittings, S., K. Benson, P. Souik, and M. Tartt. 2002. Sanctuary Science: Evaluation of Status and Information Need. Available at: http://sanctuaries.nos.noaa.gov/library/national/science_eval.pdf

within the Draft Management Plan are at a larger-scale than those identified by Gittings *et al*. (2002) and involve understanding the function of GRNMS within the larger context of the southeast United States continental shelf ecosystem. Thus, there are site-specific needs (e.g., various types of oceanographic data) and there are ecosystem-wide needs (e.g., investigate ecosystem process).

Recent and ongoing research at GRNMS addresses many of the research needs identified in the Gittings *et al.* (2002) and the Draft Management Plan. The proposed FY2004 and FY2005 projects (GRNMS and the Refugia Concept, Biogeographic Assessment) directly address research needs of the sanctuary: various types of oceanographic data; specific types of GIS compatible data; effects of fishing/harvest on predator prey dynamics and levels; and population trends for key species and communities. Further, the proposed research investigates ecosystem processes, contributes to the designation of marine research area, assesses and characterizes sanctuary resources, and provides for enhanced monitoring programs. The Biogeographic Assessment will also consolidate data from previous studies into a unified spatial framework.

As for research gaps, two areas stand out: fish population monitoring and measurement of population vital rates. Currently, two techniques are used for fish population monitoring: traps and visual census. Traps are limited in the species sampled and the visual censuses are limited by the amount of area covered and to some extent by the species sampled. Recognizing these limitations, GRNMS held a workshop to evaluate methods of fish population assessment at the scale of GRNMS. A number of techniques were reviewed including visual transect, fixed video, and acoustic. The research plan is to compare as many techniques as possible, and this was completed in part during May 2004 cruise aboard the NOAA Research Vessel *Nancy Foster*. Additional comparative work is still necessary.

The measurement of fish population vital rates contributes to a more detailed understanding of population dynamics within the sanctuary. With this more detailed understanding comes an increase in required sampling, effort, and funding. Previous work quantified movement rates of black sea bass from the sanctuary[16]. Similar work is needed for multiple species for multiple population vital rates to understand the role of GRNMS in the larger context of the southeast United States continental shelf. Priority species for GRNMS, include species managed by the SAFMC. This topic could serve as the basis for FY06 NCCOS/ONMS proposed studies with GRNMS.

6. Overview of NCCOS Science Capabilities

NCCOS was formed in March 1999 to concentrate coastal research capabilities within a National Ocean Service (NOS) office. Elements forming NCCOS were drawn from the NOS and the National Marine Fisheries Service (NMFS). NCCOS is composed of a

[16] Sedberry, GR; McGovern, JC; Barans, CA. 1998. A comparison of fish populations in Gray's Reef National Marine Sanctuary to similar habitats off the southeastern U.S.: Implications for reef fish and sanctuary management. Proceedings of the Gulf and Caribbean Fisheries Institute 50: 452-481.

headquarters in Silver Spring, Maryland, and five research centers: the Center for Sponsored Coastal Ocean Research in Silver Spring, Maryland; the Center for Coastal Monitoring and Assessment in Silver Spring, Maryland; the Center for Coastal Fisheries and Habitat Research in Beaufort, North Carolina; the Center for Coastal Environmental Health and Biomolecular Research in Charleston, South Carolina; and the Hollings Marine Laboratory in Charleston, South Carolina.

The focus of NCCOS is to provide useful and valuable scientific information and services through the conduct and support of research to further the NOAA environmental and economic missions. The scientists within NCCOS conduct applied research and manage complex long-term research projects. The projects provide a link between research science in academia and the needs of those who make decisions on use of coastal and marine areas. Driven by NOAA's mandates in content and in timing, the science conducted and supported by NCCOS focuses on applicability to agency and constituents' needs for practical answers.

Each Center has specific capabilities and research expertise in important ocean and coastal issues and contributes in its own way to the overall NCCOS mission.

Center for Sponsored Coastal Ocean Research – CSCOR provides funding to academic and federal researchers investigating a wide range of science issues directly related to NOAA's management needs. Funded programs include GLOBEC (Global Ocean Ecosystem Dynamics) and ECOHAB (Ecology and Oceanography of Harmful Algal Blooms). More information about CSCOR can be found on the Center's factsheet (http://coastalscience.noaa.gov/documents/factsheet_cscor.pdf) and on their website (http://www.cop.noaa.gov).

Center for Coastal Monitoring and Assessment – CCMA conducts monitoring and assessment of coastal environmental quality, coastal habitats, and coastal resource distribution. Major programs exist in biogeographic characterization, bioeffects monitoring, and remote sensing. CCMA also has extensive GIS expertise. More information about CCMA can be found on the Center's factsheet (http://coastalscience.noaa.gov/documents/factsheet_ccma.pdf) and on their website (http://ccmaserver.nos.noaa.gov).

Center for Coastal Fisheries and Habitat Research – CCFHR conducts research on habitat ecology, fisheries oceanography, and plankton ecology and physiology. Research blends field-base studies, laboratory studies, and modeling activities. The Center has also the capability to culture marine and estuarine species. In addition, NMFS researchers are part of CCFHR and research themes include marine mammal and sea turtle research, reef fish ecology, and population dynamics. More information about CCFHR can be found on the Center's factsheet (http://coastalscience.noaa.gov/documents/factsheet_ccfhr.pdf) and on their website (http://shrimp.ccfhrb.noaa.gov).

Center for Coastal Environmental Health and Biomolecular Research – CCEHBR used a combination of chemical, biomolecular, toxicological and ecological techniques to

examine health of coastal ecosystems, environmental quality, and public health impacts. Major research areas include marine ecotoxicology, marine pathology, coral health, invasive species management, protected species health, marine forensics, and environmental risk analysis. More information about CCEHBR can be found on the Center's factsheet (http://coastalscience.noaa.gov/documents/factsheet_ccehbr.pdf) and on their website (http://www.chbr.noaa.gov).

Hollings Marine Laboratory – HML opened in 2002 and provides science and biotechnology applications to examine the linkages between the environment and human health. HML is co-occupied by several partnering institutions including NCCOS, South Carolina Department of Natural Resources, University of Charleston, National Institute of Standards and Technology, and the Medical University of South Carolina. More information about HML can be found on the Center's factsheet (http://coastalscience.noaa.gov/documents/factsheet_hml.pdf) and on their website (http://www.nccos.noaa.gov/about/hml.html).

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